DOCUMENT RESUME

ED 308 148 SP 031 220

AUTHOR Lotan, Rachel A.
TITLE Complex Instruction: Theory and Classroom Implementation.
PUB DATE Mar 89
NOTE 39p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, CA, March 27-31, 1989).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Educational Innovation; Elementary Secondary Education; *Grouping (Instructional Purposes); *Instructional Development; Learning Strategies; Program Implementation; *Research Utilization; Small Group Instruction; *Teaching Methods

ABSTRACT

This paper illustrates how theoretical research and development of an innovative instructional approach have been successfully integrated with teacher training and classroom implementation. This approach, called "Complex Instruction", was designed to facilitate the development of cognitive, academic, and linguistic functioning of all students in heterogeneous classrooms. Organization of the classroom to provide equal access to the critical features of instruction (i.e., the curricular materials, interaction with the teacher, and interaction with peers) is among the crucial elements of this approach. Organizational sociology is used as a framework to develop an argument regarding the relationship between mastery of a knowledge base underlying a specific classroom technology, and its actual implementation in the classroom. To support this argument, an analysis is presented of the underlying knowledge base and its relationship to the central features of classroom implementation of Complex Instruction, the instructional technology. In addition, descriptions are given of the conditions for developing teacher conceptual understanding, and the implications of explicitly incorporating theory and research into the teacher training implementation process. (JD)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED308148

Complex Instruction:

Theory and Classroom Implementation

Rachel A. Lotan

Stanford University

Paper to be presented at the AERA annual meeting,

San Francisco, CA, 1989

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

R. Lotan

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

SP031820

BEST COPY AVAILABLE

1 Introduction

The purpose of this paper is to illustrate how theoretical research and development of an innovative instructional approach have been successfully integrated with teacher training and classroom implementation. This approach, called Complex Instruction, was designed to facilitate the development of the cognitive, academic, and linguistic functioning of all students in heterogeneous classrooms. Organization of the classroom to provide equal access to the critical features of instruction (i.e., the curricular materials, interaction with the teacher, and interaction with peers) is among the crucial elements of this approach.

I use a framework from organizational sociology to develop my argument regarding the relationship between mastery of a knowledge base underlying a specific classroom technology, and its actual implementation in the classroom. To support this argument, I analyze the underlying knowledge base and its relationship to the central features of classroom implementation of Complex Instruction, the instructional technology. In addition, I describe the conditions for developing teacher conceptual understanding, and the implications of explicitly incorporating theory and research into the teacher training and the implementation processes.

Building upon relevant theory and research and developing a well-defined pedagogical framework to formulate clear and explicit strategies for implementation, is an important, although often neglected aspect of many educational innovations. On the one hand, some developers of educational innovations boast with temerity about producing "teacher-proof" curricula, thereby negating the critical importance of the teacher's mental operations and her classroom activities in the process of implementation. On the other hand, because of multifold

professional pressures, teachers often express impatience with and distrust of "theory." Given numerous unfortunate experiences with the delivery of the average staff development workshops, teachers now often call for the bottom line. "What do I do Monday morning?" is a familiar question asked of many agents of change. The erroneous impression is created that teachers do not care about and for "theory."

Although understandable in their respective contexts, both perspectives are unproductive in the long run. First, and as expressed in recent reform proposals, at present there seems to be more adequate public recognition for the critical role of the teacher. Clearly, success or failure of a program depends ultimately on the teachers' and the students' performances in the classrooms. Second, theory should pay off for teachers. When an innovative program addresses problems that are directly relevant to the teacher's everyday classroom experiences, when concepts and principles are clearly defined and their practical implications made explicit, teachers can actually experience and benefit from the interaction between theory and practice.

In his discussions, Fullan (1982, 1981a, 1981b) identified, among others, two major factors of the implementation process: 1) the conceptual clarity of goals, principles and features of the innovation itself, and 2) the conceptual understanding of the innovation by the teachers. Obviously, the second factor is dependent upon the first. One necessary, but not sufficient condition for the conceptual understanding of an innovation by the teacher, is conceptual clarity of the innovation. Any proposed educational innovation needs to have a sound theoretical base and must include practical suggestions for implementation.

When this is not the case, teachers are presented with insoluble conceptual and technical problems. Gross, Giacquinta and Bernstein (1971), and Smith and Keith (1971) documented the classic histories of two educational innovations, whose failure of implementation was, in part, attributed to lack of clarity and

specificity. On a much larger scale, Berman and McLaughlin (1977) also found that clarity was an important predictor of success, and that lack of clarity or "staff uncertainty about what (the teachers) were expected to do generated severe implementation problems and contributed to project demise once federal funding ended" (p. 71). The authors' analysis strongly suggested that "teachers can implement innovations better if they clearly understand the project's purposes and precepts" (p. 95).

Shulman (1974) has voiced the need to make the mental life of teachers an important topic in educational research. He insists

> that it will be necessary for any innovations in the context, practices, materials, or technology of education to be mediated through the minds and the motives of teachers. This will entail serious studies of the cognitive processes of teachers, their capacities and limitations, in order to develop training programs, decision aids, record-keeping technologies, and the like, to further hone the teacher's skill in adapting to learners. (p.334)

In including the cognitive dimension in a model of successful implementation of educational changes and innovations, I claim that teachers, as professionals, are capable of critical and analytical responses to demands made by their environment. As professionals, they are capable of relying upon an abstract body of pedagogical knowledge to make choices and decisions.

In addition to the attention given to professional development, the educational literature points to the importance of the teachers' organizational context. Features of this organizational context include leadership by the principal, collegial interactions and support, and the existence of a feedback loop to the teachers on their performances in the classroom. Recent studies at the elementary as well as at the secondary levels (McLaughlin and Marsh, 1978; Schlechty and Whitford, 1983; Howey and Vaughan, 1983) imply that professional development of the teacher as an individual participant in the educational institution is insufficient; the organizational context and the

consequences of any actions within this context cannot and should not be disregarded or neglected. Any demand for change in traditional instructional practice needs to be accompanied and supported by changes in the organizational environment in which the teacher operates. This principle, repeatedly tested in organizational theory and research (see Perrow, 1967), has come to be called "restructuring."

2 The Theoretical Framework: Aspects of Classroom Technology

Based on work at the Environment for Teaching Program at Stanford (Cohen, Deal, Meyer and Scott, 1973), many educational researchers have found it useful to apply organizational sociology to school and classroom settings. Thereby they were able to illuminate and explain problematic issues as well as to provide a possible framework for interventions on the level of the organization and that of its participants. Following this tradition, the present study applies organizational theory in its focus on aspects of the instructional technology. First, technology refers to characteristics and features of instruction such as the composition of the student body, materials and activities prescribed by the curricula, and their degree of uniformity or differentiation. Second, technology includes operations: routine or non-routine instructional practices and routine or non-routine strategies of pedagogical decision making. Third, technology includes the existing knowledge of the participants: understanding of certain cause-effect relations, possession of relevant information, and the intellectual sophistication and specialization required to perform a complex task.

Materials

Perrow (1967, 1970) classified materials of the technology according to their familiarity in the eyes of the performer and according to their variability. By applying Perrow's argument to schools, and from the point of view of the teacher, the student

body can be considered "raw material" as can the actual curricular activities and materials used by these students. When the student body is heterogeneous as is the case in racially/ ethnically, socially and academically mixed settings, the material can be defined as highly ambiguous and varied. When the curricular materials and activities used by these students are differentiated and diverse, unpredictability or uncertainty, and variability are significantly increased.

Operations

The concept of operations refers to characteristics of the work process (Scott, 1981). A widely used typology of operations, for example, is the distinction between large batch and mass production on the one hand, and small batch and unit production on the other.

In the context of the classroom, Cohen and Intili (1981) used this distinction when they defined the traditional methods of teaching as "large batch processing." In their analysis, "instruction of this type shows a low degree of differentiation and a low level of non-routine decision making." (p.8) Traditional teaching methods include lecturing and providing information to the class as a whole, questioning selected individuals through recitation, directly supervising students' individual seat-work, and disciplining. Studies have shown that these kinds of teaching methods are the most prevalent in elementary as well as secondary school classrooms (Goodlad, 1983; McNeil, 1988).

When instruction is conducted in small groups or individually, it is similar to small batch or unit production. If, in addition, activities and materials are non-standard and students' tasks are varied and open-ended, from the point of view of the teacher there are high levels of differentiation and unpredictability in the arrangements required for classroom management.

In small-group and in individualized instruction, teachers can use numerous non-routine teaching behaviors when setting the stage for or responding to student activities. In heterogeneous classrooms, when instruction is organized in small groups and materials are differentiated, lecturing and directly supervising students becomes an impracticable strategy for the teacher (Cohen, 1986; Cohen and Lotan, in press). Thus, the teacher needs to delegate authority to the students and make them responsible for their own and their groupmates' task engagement and learning. Delegation of authority does not mean, however, that the teacher gives up control over what happens in the classroom. But rather than directly supervising students, the teacher establishes an alternative organizational and normative system in which the installation of cooperative norms and specific student roles keeps students on-task (Cohen, 1986). In addition to delegation of authority, non-routine teaching behaviors include giving specific and sound feedback to individuals and groups, and stimulating and extending students' thinking through actual experiences and discovery.

During these kinds of teaching situations, teachers need to engage in a complex, reflective decision-making process. In this context, Intili (1977) likened the role of the teacher to that of the physician who, as described by Shulman and Elstein (1975), processes, evaluates, and makes decisions based upon large quantities of different types of information.

Knowledge

Scott (1981) argued that "an emphasis on knowledge as compared to materials or operations marks a shift from an objective to a more subjective conception of technology." Considering issues of knowledge and rationality, March and Simon (1958) distinguished between routine and non-routine responses to the environment made by members of an organization. Routine responses are previously developed and learned. The kind of knowledge that underlies such a response is defined by March and Simon as a performance

program: highly codified, regulated, and explicit, providing immediate and routine, step-by-step responses to environmental stimuli.

Non-routine responses are problem-solving activities that take into account the participant's previous knowledge as it interacts with practical uses of this knowledge in building a simplified model of the present situation -- a model which is "the outcome of psychological and sociological processes, including the (participant's) own activities and the activities of others in his environment" (p.139). March and Simon qualified these problem-solving activities in the following way: "Problem-solving activities can generally be identified by the extent to which they involve search: search aimed at discovering alternatives of action or consequences of action." (p. 140) Problem-solving activities reflect reliance upon a broader and more abstract body of knowledge that enables the participant to make non-routine, analytical responses by taking into account different alternatives, immediate outcomes, and long-term consequences.

Following March and Simon, Perrow (1967) distinguished between two types of search processes: analyzable and unanalyzable. The former is logical, systematic and analytical, and the latter is less "formal." This second type "occurs when the problem is so vague and poorly conceptualized as to make it virtually unanalyzable. In this case, no "formal" search is undertaken, but instead one draws upon the residue of unanalyzed experience or intuition, or relies upon chance and guesswork" (p.196). Analyzable search processes can be routine or non-routine.

Teachers, like other practitioners, use both kinds of knowledge as defined by March and Simon, and both kinds of analyzable search processes as defined by Perrow. Teachers, like engineers (Perrow, 1967) for example, use routine procedures to treat routine tasks but also to identify situations which cannot be dealt with in routine ways. When routine responses are not adequate, attempts are made to solve problems by applications of

a body of knowledge that is complex and abstract. Although not situation-specific, this body of knowledge needs to be organized and structured so as to permit systematic application of its concepts and principles.

The educational innovation which is the subject of this study is an instance of an engineering model. The innovation itself has a solid theoretical basis that is supported by educational research; teachers implementing the program receive thorough theoretical and practical training and their performances are closely monitored by the trainers through a sound feedback process that emphasizes the linkages between theory and practice. When the necessity arises to respond in routine or non-routine ways to high degrees of variability in the students and differentiation in the task activities, the teachers are able to use analyzable search procedures on an abstract body of pedagogical knowledge.

3 Formulation of the Hypotheses

Researchers have stated propositions about the relationships between the various aspects of technology. For example, Perrow (1967) hypothesized about the relationship between features of the materials and characteristics of the search processes. In their analysis of the relationship between materials and operations, Cohen and Bredo (1975) found a highly significant relationship between materials variation and student grouping. Intili (1977) investigated the relationship of Reflective Decision Making (RDM) to variability and diversity in the student body, and in the instructional materials. According to the framework of this study, RDM would be an aspect of the operations of the technology.

In her review of Perrow's framework, Intili (1977:17-18) points to the critical importance of the existence or non-existence of a distinct body of knowledge "to which the task performer can refer...when analyzing problems related to task performance."

Neither Perrow nor Intili, however, make an analytical distinction between the concept of knowledge and its applications in form of search processes. In this study, I analyze the relationship between knowledge and operations, given variability in materials and the existence of a body of relevant knowledge.

The first hypothesis of the study is stated as follows:

> Given variability in materials and the existence of a body of relevant knowledge that defines analyzable search procedures, teachers' conceptual understanding of this body of knowledge will be positively related to the frequency of non-routine behaviors in the operations of the technology.

In this hypothesis, then, I investigate the relationship between teachers' conceptual understanding of principles and features of the innovation and their instructional practices during the implementation process. My question in simple terms is: how is what teachers know about the innovation related to what they are doing when implementing it.

In his review of the organizational literature, Scott (1981) established a direct relationship between the state of knowledge and the effectiveness, or productivity of the organization. Scott's proposition serves as the basis for the formulation of the second hypothesis and is stated as follows:

> Given equal access to sources of a relevant body of knowledge, teachers' conceptual understanding of this body of knowledge will be positively related to productivity.

In other words, if teachers know what they are doing, they will be more productive in terms of immediately observable outcomes, such as the amount of curriculum covered.

To formulate the third hypothesis, I view teachers who implement Complex Instruction as adult learners in organizational settings. These teachers, like their students, go through a process of

absorbing, assimilating, organizing, applying, practicing, and finally mastering the knowledge which then becomes part of their pedagogical repertoire. Teachers, like their students, will be more successful learners when adequate feedback and reinforcement are provided to them, when they have the opportunity to reflect and discuss their experiences with colleagues and experts, and when organizational and environmental conditions are conducive to and supportive of the learning process.

When teachers master the knowledge base, the effects of their conceptual understanding of a specific innovation might go beyond the limits of the "here and now." As all conceptual learning (Bruner, 1960; Gagne, 1977), it should serve the learners in other, similar situations that present problems like the ones addressed by the innovation.

In the third hypothesis, I investigate the continuity of learning by searching for visible indicators of the innovative technology in various problem-solving situations. Looking for the observable applications of the newly acquired behavioral skills seems to indicate that I am expecting to find specific transfer of training. This is not the case. As argued earlier, the technological operations, indicated by the non-routine teaching practices, are not directly programmable behaviors. Rather, they are the manifestations of a decision-making process tightly linked to the state of knowledge of the participants. Thus, it is only when transfer of principles, that is conceptual understanding has occurred, that one would expect to find indications for transfer effects in the form of non-routine behaviors in other problem-solving settings.

Thus, the third hypothesis is stated as follows:

> Teachers' conceptual understanding of the body of knowledge will be positively related to transfer effects of non-routine behaviors learned and used in certain problem-

solving situations, to other, similar problem-solving situations.

In other words, to the extent that teachers have mastered the body of knowledge underlying the innovation, they will be able to use their knowledge and skills in many other situations. Thus, I expect to find a broader and more profound change in the teachers' overall teaching practices, a change which surpasses the boundaries of the proposed innovation.

4 Complex Instruction: The Instructional Innovation

Complex Instruction, developed at Stanford University School of Education by Drs. E.G.Cohen and E.A.DeAvila, and their associates, is an instructional approach that has the following critical features: 1) a curriculum that includes multiple ability tasks, 2) a system of classroom organization that modifies the traditional authority structure of the classroom, and, 3) because of the special attention to the classroom performances of the low-status child, instructional strategies for treating status problems in the classroom. Complex Instruction, accompanied by the Finding Out/ Descubrimiento (FO/D), math and science, English-Spanish curriculum, has been implemented in over 200 elementary schools classrooms in the San Francisco Bay Area. Evaluations of the program have consistently shown increased learning gains in the math, reading, and when tests were available, in the science subscales of the CTBS standardized achievement tests. (Cohen and De Avila, 1983).

The Curriculum

The Finding Out/ Descubrimiento curriculum consists of illustrated activity cards in English and Spanish, and accompanying worksheets to be completed by the students. The activities are grouped around 17 thematic units, ranging from measurement and change to electricity and magnetism. Working in small groups at learning centers, students use manipulatives to

perform scientific experiments. They read the instructions, plan experiments, hypothesize about outcomes, observe, measure, and record the outcomes. In addition to the traditional academic abilities of reading, writing and computing, students have the opportunity to use other, different intellectual abilities such as reasoning, visual and spatial thinking, precision in work, and interpersonal skills. In fact, the successful completion of these tasks requires the application of multiple intellectual abilities.

In Complex Instruction, there are six or seven different learning centers in simultaneous operation. At each learning center, students use different activities, write on different worksheets, and use different manipulatives. From the point of view of the teacher, there is a high degree of variability and differentiation in the materials of the technology.

Organization of the Classroom

Peer interaction (lateral communication among the workers/ students, in organizational terms) is a central feature of Complex Instruction and the main predictor of learning gains at the individual and at the classroom level (Leechor, 1988; Cohen and Lotan, in press). To boost levels of peer interaction the teacher organizes the classroom in a non-traditional way. First, the teacher delegates authority to the students and makes them responsible for their own and their groupmates' learning and task engagement. As explained earlier, when six learning centers are in simultaneous operation, it becomes impossible for the teacher to directly supervise all the students and continuously facilitate their completion of the tasks. Thus, delegation of authority is viewed here as the obverse of direct supervision by the teacher. Cohen and Lotan (1988) have shown that direct supervision is detrimental to peer interaction.

Second, delegation of authority by the teacher is supported by a system of cooperative norms and student roles. Students are

trained and encouraged to offer and request help, to explain the task to members of their groups, and in general to serve as resources to one another. In addition, each member has a role in the group, e.g., facilitator, checker, reporter, clean-up, and safety officer. The assignment of roles is rotated so that all students have the opportunity to perform in all roles. In a sample of classrooms implementing FO/D during the 1984-85 school year, Zack (1988) showed that facilitator-type talk by the students was directly related to their task-related talk. In addition to delegating authority to students, establishing and maintaining this cooperative management system by talking about cooperative norms and roles is another example of the non-routine teacher practices implemented in Complex Instruction.

Third, to balance the interaction among all members of the group and to prevent dominance of group interactions and decisions by high-status students, teachers implement strategies to treat these status problems. These instructional strategies were developed based on extensive theoretical and empirical research, and include talking about multiple abilities, and assigning competence to low-status students. The treatments and their outcomes were described in more detail elsewhere (Cohen, Lotan and Catanzarite, 1988).

Summary of Non-Routine Operations in Complex Instruction

Peer interaction in small group instruction, delegation of authority to the students by the teacher, a system of cooperative norms and student roles, and the status treatments are theoretical precepts. The relationships among these central features of the instructional approach and students' achievement gains were defined and investigated through extensive empirical research. I have described the sources of the underlying knowledge base in greater detail elsewhere (See Lotan, 1985). Here, I will only briefly review those main features directly relevant to this study.

Based on extensive research of Complex Instruction, peer interaction has emerged as a reliable and robust measure of the quality of program implementation by the teacher (see Cohen and Lotan, in press, for detailed analysis of the effects of direct supervision by the teacher and peer interaction on student achievement). Since it is the teacher who sets the stage for this peer interaction, it is defined here as the first aspect of the operations of the technology, from the teacher's point of view. As explained earlier, delegation of authority to the students by the teacher is a central concept and the second kind of non-routine operation. However, delegation of authority is not directly observable. Thus, a negative indicator of delegation of authority is its obverse manifestation: direct supervision or facilitation of students' task engagement by the teacher. Teachers' talk about cooperation and roles is another indicator of non-routine behaviors in Complex Instruction. Additional indicators would be treatments of status by the teacher. However, because of substantive and methodological limitations the measures of the status treatment could not be used for purposes of this study.

5 Classroom Organization in Regular Settings

The relationship between classroom organization and opportunities for the teacher to engage in non-routine operations is an important consideration for purposes of this study. In Complex Instruction (FO/D), many aspects of the organizational arrangements are prescribed by the program. For example, during the summer workshop teachers were instructed to set up an optimal number of learning centers so that more than one and less than six children could work at any one center. This meant that in an average classroom of 30 students, there were six or seven learning centers in operation. During the training and the feedback sessions, trainers urged the teachers to let go, not to hover, to minimize facilitation, to let the children experiment and find out information for themselves. Teachers were encouraged

to use the system of cooperative norms and student roles, and thus manage the classroom by talking about cooperation and roles.

During regular classroom periods, the organizational structure of the classroom is more at the discretion of the teacher, although certainly not exclusively so. Much depends on the nature of the curricular materials used (e.g., the textbooks, the worksheets, the use or non-use of manipulatives), the nature of the tasks, and the overall task arrangements. These are more often than not determined at the school or even at the district level.

There are theoretical as well as practical differences between a learning center in FO/D and what had to be considered a learning center during regular classroom periods (Non-FO/D). An FO/D learning center includes the task cards, the worksheets, and the manipulatives that make up the activity. Students work cooperatively to perform the task and they complete the worksheets individually. Interaction is encouraged, promoted, and an integral part of the operations at the centers.

In Non-FO/D, the observers rarely encountered a learning center that looked anything like that. In regular classrooms, students rarely work cooperatively or share responsibilities as members of a group. They might sit around desks that are in proximity and communication is possible. However, it is seldom encouraged and it would probably be considered cheating. Thus, in Non-FO/D, any physical arrangement in the classroom in which task-related interaction among students in small groups could potentially occur, was considered a learning center.

When negotiating access to the classrooms for purposes of observations, I had asked for permission from the teachers to observe during periods in which they set up physical arrangements comparable to learning centers. Some teachers used small groups and larger groups (more than five students) during some math and reading lessons. However, these groups were often ability groups, rather than heterogeneous groups, as prescribed in FO/D.

Sometimes teachers used small groups for art lessons, in preparing for a school play or for holiday festivities.

The use of small groups as an instructional strategy is dependent on a number of factors in the teacher's organizational context, in addition to the teacher's conceptual understanding of a specific approach like Complex Instruction. These organizational factors might school or district policy, availability of adequate curricular materials, and teacher's previous experiences with small group instruction. Thus, to examine the relationship between teachers' use of non-routine operations in other settings as defined in the third hypothesis, it was necessary to control for the organization of the classrooms, such as the percentage of students in small groups.

6 Setting and Sample

During the 1982/83 academic year, Finding Out/ Descubrimiento was implemented in fifteen classrooms in ten schools from three school districts in the San Jose area. In the fifteen classrooms, approximately 390 second, third, fourth and fifth graders participated in Finding Out. Students were largely of Hispanic descent, but Whites, Asians, and Blacks were also represented. Parental background was from working to lower middle class.

The teachers in these classrooms worked under varying organizational arrangements during the implementation of FO/D. Some teachers teamed with the school resource teacher, others with bilingual instructional aides. One teacher teamed with the special education teacher who mainstreamed her students during FO/D. The sample of teachers and classrooms in this study is a sub-sample of a larger study reported elsewhere (Lotan, 1985). For purposes of this study, I have chosen to analyze data only for those teachers who were the regular classroom teachers and implemented FO/D on a consistent basis with all the students in their classrooms. Thus, the total number of teachers in the sample of this study was 15.

To test the third hypothesis, data regarding the teachers' instructional practices during Non-FO/D periods, yet in structurally similar settings, was required. Initial observations and subsequent conversations with one of the teachers in the sample resulted in the conclusion that in Non-FO/D, she conducted individualized instruction exclusively. This was due to school-wide policy. Thus, one teacher was dropped from the sample for purposes of data collection relevant for the third hypothesis. The number of teachers from whom data for the third hypothesis were collected, was 14.

7 The Treatment

The teachers in this study participated in a two-week summer workshop at the Bilingual Consortium in San Jose and at Stanford University. During the first week of the workshop, the teachers were introduced to the theoretical framework and rationale of FO/D. They were exposed to psychological, sociological and social psychological theories and research findings and their applications to classroom settings. During the second week of the workshop, the teachers had the opportunity to practice teaching FO/D to a group of 30 students. While teams of teachers experienced instruction, they were observed, videotaped and then given specific feedback on their performance. In addition to this hands-on experience, teachers also planned for the implementation of FO/D in their classrooms.

In January 1983, a day-long workshop was provided by the Stanford staff. The agenda for this meeting was designed based on systematic observations of the teachers' classrooms. This workshop emphasized principles and non-routine behaviors that had still not become an integral part of the teachers' repertoire of teaching practices, such as giving specific feedback to the students, stimulating and extending the students' thinking, and treating status problems.

As part of the training program, the Stanford staff also provided three formative feedback sessions to participating teachers. These feedback sessions were based on summaries of systematic classroom observations and were problem-solving sessions in which the participants went back and forth between theory and practice. The feedback sessions were designed by utilizing the general theoretical principles of soundly based evaluation (Dornbusch and Scott, 1975). The sessions were defined as teaching and learning opportunities intended to help teachers attain conceptual understanding and knowledge of the program. In her analysis of a sample of FO/D classrooms in 1984-85, Ellis (1987) found that the number of these kinds of feedback sessions was significantly related to the implementation of non-routine behaviors by the teacher.

In addition to the support from Stanford trainers, the staff of the Bilingual Consortium also provided teachers with much needed help. Members of this staff organized and facilitated monthly meetings, and most importantly, provided the curricular materials as well as the manipulatives needed for the activities.

Teacher's conceptual understanding was developed in a year-long process that began during the summer workshop. This conceptual understanding evolved through classroom implementation by the teacher, and feedback on this implementation. Although they received identical treatment, the individual outcomes of this treatment for the teachers' conceptual understanding varied. In addition to the training, organizational factors were shown to relate to teacher's conceptual understanding. Parchment (in progress) found that organizational context (measured by principals' coordination of resources) was directly related to teacher's conceptual understanding of the program. During the implementation process, as teacher's grappled with the challenges of this innovative instructional strategy, the role of the principal in providing and coordinating logistical support (time, space, materials) became essential.

8 Sources of Data and Measurement Procedures

Data for the measurement of teacher's conceptual understanding of FO/D were obtained from a Final Teacher Interview and a Final Teacher Questionnaire administered in June 1983. The interview contained 29 question, many of them open-ended. Most of the questions were formulated so as to invite the teachers to relate their experiences in the implementation of FO/D to concepts and principles in the underlying knowledge base. The Questionnaire contained 40 forced-choice questions, many of which were adapted from the Rand Report (Berman and McLaughlin, 1977). All teachers in the study were interviewed and all teachers filled out the questionnaire.

Two independent scorers interpreted and coded the content of the Final Teacher Interview. The scorers were knowledgeable about the theoretical framework of FO/D and thus able to make inferences from the teacher's responses about the accuracy of their answers as compared to the criteria derived from the theoretical knowledge base. The mean level of agreement between the scorers for the Final Teacher Interview was 91%. Based on this coding, an overall index of teacher's conceptual understanding was constructed. A detailed description of the measurement procedures for teacher's conceptual understanding was described elsewhere (Lotan, 1985, Chapter 5).

Data about teachers' and students' behaviors during FO/D and during other settings (Non-FO/D) were gathered from classroom observations using two separate instruments. The Teacher Observation Instrument provides information about the frequencies of routine and non-routine teaching behaviors. The Whole Class Observation Instrument provides information about grouping and activity patterns of students during learning center time. Using the Teacher Observation Instrument, bilingual observers tallied, for ten minutes at a time, the frequency of the routine and non-routine teacher behaviors. The categories relevant for this study are: teacher facilitates, teacher talks about cooperative

behaviors, and teacher talks about roles. Fourteen teachers were observed ten times and one teacher was observed eight times. From mid-April through the first week of June, observers also visited the classrooms of the FO/D teachers during other instructional periods: math, reading, art, and physical education. The observers gathered data about teacher behaviors using the same instrument, in identical manner. All fourteen teachers of this sample were observed ten times. Inter-observer reliability for the Teacher Observation Instrument was 91% agreement.

Using the Whole Class Instrument, observers counted the number of students at each learning center who were talking or talking and manipulating materials, manipulating only, reading and writing, disengaged, etc. The category of talking or talking and manipulating, is of particular importance for this study. The percentage of students in this category out of the total number of students in the classroom constitute the measure for %students talking and working together. Two observations on ten different occasions were taken for fourteen classrooms during FO/D and two observations on eight different occasions were taken of one of the classrooms. During Non-FO/D periods, the observers used the same instrument to record grouping and activity patterns of students. From mid-April to beginning of June, ten classroom observations were done in each of the fourteen classrooms. Inter-observer reliability for the Whole Class Observation Instrument was 91% agreement.

The issue of whether the sampling of teacher behaviors and students' activities was adequate to yield a reliable estimate can be addressed through the examination of the variation in these measures within and between observations of the individual teachers or classrooms. An analysis of variance should show that for all the relevant behaviors, there is more variability between observations taken on different teachers and classrooms than there is within the set of observation taken on the same teacher or classroom. The implications of such analyses of variance for the various categories are that the teacher is a significant and

stable source of variation. Therefore, the aggregated average rates of the observations are adequate measures of a particular teacher's behaviors. The results of the analyses of variance for all variables in FO/D and Non-FO/D were statistically significant. It was therefore legitimate to aggregate the observations by teacher and by classroom. Because the analysis of variance was not statistically significant for "teacher talks about multiple abilities," this particular variable, indicating status treatment by the teacher, was not used in this study.

9 Operationalization of the Hypotheses

Table 1 is a summary of the concepts, their indicators and sources of data for this study.

Table 1 here

The following predictions are derived from the three hypotheses of the study. From the first hypothesis:

> Given the academic and linguistic heterogeneity of the student body and the variability of curricular materials as well as the existence of a relevant body of knowledge that underlies the Finding Out/ Descubrimiento program, it is predicted that the index of conceptual understanding will be related to non-routine teaching behaviors in the following direction: negatively to teacher facilitates, positively to teacher talks about cooperation and roles, and positively to the % of students talking and working together.

From the second hypothesis:

> Given the participation of the teachers in the treatment, it is predicted that the index of conceptual understanding will be positively related to the number of curricular units completed during the academic year.

From the third hypothesis:

The index of teacher's conceptual understanding will be related to non-routine behaviors in non-FO/D settings in the following directions: negatively to teacher facilitates during Non-FO/D, positively to teacher talks about cooperation and roles in Non-FO/D, and positively to %of students talking and working together in Non-FO/D.

10 Results

Table 2 presents the descriptive statistics of the variables in the study. A comparison of the non-routine behaviors in FO/D and non-FO/D settings is of particular interest. Teachers facilitated more often in FO/D than in Non-FO/D settings. This might seem contradictory to the argument that there is more direct supervision by the teacher in regular settings than in small group settings. However, further analyses showed that, in general, the teachers were more active during FO/D periods than they were during Non-FO/D periods. On the average, they engaged more frequently in interactions with students both through routine as well as non-routine behaviors.

Table 2 also shows that the level of peer interaction (%students talking and working together) was significantly different in the two settings ($t=-3.42$, $p<.001$).

Table 2 here

Tables 3 and 4 present the correlations matrices between the variables of the first and the second, and of the third hypotheses respectively. Table 3 shows the correlations of the index of conceptual understanding and non-routine operations in FO/D, and # of units covered. The relationship between the index of conceptual understanding and teacher facilitates was $r=-.62$, $p<.01$.[1] The relationship between the index of conceptual understanding and teacher talks about cooperation and roles was $r=.41$. n.s. The relationship between the index and %students

talking and working together was in the predicted direction, r=.31, n.s.

Table 3 also shows that there was no relationship between the index of conceptual understanding and the number of units covered. There was, however, a statistically significant negative relationship between the latter and %students talking and working together.

Table 3 here

Table 4 presents the strength of the relationships between the index of conceptual understanding and non-routine behaviors and classroom organizational arrangements in Non-FO/D settings. This table shows that there was a negative relationship between conceptual understanding and teacher facilitates in Non-FO/D, r=-.37,n.s. The relationships between the index of conceptual understanding and teacher talks about cooperation and roles, and %of students talking and working together were r=.44, n.s. and r=.50, p<.05, respectively. These relationships were in the direction predicted by the hypothesis. In addition, the %of students in small groups was positively significantly related to %students talking and working together, (r=.59, p<0.05) and to teacher talks about cooperation and roles (r=.57, p<.05).

Table 4 here

In the derivation of the third hypothesis I specified that the predicted relationship should be tested under conditions of comparable structural arrangements in the classrooms. Thus, I tested the relationships between the index of conceptual understanding and the non-routine operations, controlling for classroom arrangements. Table 5 presents the results of the analyses for the test of the third hypothesis.

---

1. Probability levels were calculated for one-tailed tests because the directions of the variables were predicted in the hypotheses.

Controlling for %students in small groups strengthened the relationships of conceptual understanding and the non-routine operations. When %students in small groups was used as a control variable, the relationships between conceptual understanding and teacher facilitates was r=-.41, n.s.; between conceptual understanding and teacher talks about cooperation and roles was r=.47, p<.05; between conceptual understanding and %students talking and working together r=.56, p<.05.

Table 5 here

11 Discussion

The data were partially supportive of the first and the third hypotheses. The second hypothesis predicting a positive relationship between teacher's conceptual understanding and productivity, i.e., curriculum coverage, was not supported.

In the analyses of the data relevant to the first and the third hypotheses, all correlations coefficients were in the predicted direction. However, not all predicted relationships achieved statistical significance. For the first hypothesis, the relationship between conceptual understanding and teacher facilitates was statistically significant, but the relationships between teacher talks about cooperation and roles, and %students talking and working together were not.

In previous research, the %students talking and working, an indicator of peer interaction, was shown to be a central concept in classrooms implementing FO/D and an adequate indicator of the quality of implementation of the program. As such, it is related to other factors of classroom and even school organization. For example, by using a path model analysis, Cohen and Lotan (in press) found that the level of peer interaction was negatively affected by teacher facilitation (see also Table 3). Parchment (in progress) found that coordination by the principal was significantly, positively related to quality of implementation as

indicated by the percentage of students talking and working together.

For the tests of the third hypothesis, all correlation coefficients between conceptual understanding and non-routine operations in Non-FO/D settings were also in the predicted direction. However, only the relationship between conceptual understanding and %students talking and working together in Non-FO/D settings achieved statistical significance. When controlling for classroom arrangements in these settings, i.e., the percentage of students in small group, these relationships were strengthened. The relationship between conceptual understanding and teacher talks about cooperation and roles achieved statistical significance. As explained earlier, in Non-FO/D settings, features of the classroom organization that support peer interaction were more dependent upon the teacher than in FO/D settings. When the teacher has the possibility to use small groups and thus "set the stage," and when she has adequate understanding of the underlying principles, she will indeed use these behaviors as she has learned to do in FO/D. The fact that there was also greater variation in students talking and working together in Non-FO/D settings than there was in FO/D is supportive of this argument. Table 4 also showed that there was no relationship between teacher's conceptual understanding and the %of students in small group. This finding supports the argument made earlier that the use or non-use of small groups was dependent on organizational factors rather than the teacher.

The test of the second hypothesis showed that there was no relationship between conceptual understanding and # of units completed. Additional analysis also showed that the # of units completed was significantly positively related to grade level, ($r=.52$, $p<.05$) meaning that teachers and students in the lower grades completed fewer units. Many second graders in the sample were non-readers and thus much time was spent on their decoding and understanding the task cards. Their vocabularies were more limited and teachers needed more time to prepare the children for

the activities at the centers. The second graders also took more time than the older children to complete the worksheets.

Productivity might be more dependent upon organizational factors than on the teacher's understanding of the program. These organizational factors include division of labor among team members, support with collection and set-up of materials, and expert or collegial feedback. Ellis (1987) found that logistical support by the organization[2] was significantly, positively related to the total number of activities[3] completed by teachers ($r=.75$, $p<.05$) in a sample of classrooms that implemented FO/D during the 1984/85 academic year.

There were a number of serious limitations to this study. First and foremost, the small sample size presented serious methodological limitations. A larger sample size would have permitted a more conclusive test of the hypotheses. Also presentation of qualitative data illustrating some of the statistical findings would have added to the substance of this paper.

Second, the measurement of teachers' conceptual understanding, the central concept of this study, posed considerable challenges. Many researchers struggle with the problem of getting inside teachers' heads to describe what they know and what they consider important. Subjecting teachers to a formal test situation is almost always inconceivable, especially when these teachers have volunteered to implement a complex and demanding instructional innovation. One might, however, "come to terms with the inevitability of uncertain inference, and realize that such judgments are more illuminating than profession of ignorance" (Nemser and Floden, 1986).

---

2. Ellis (1987:169) defined logistical support as consisting of materials, space, and time provided specifically for the program by the school or district.

3. Each unit comprises six or seven activities.

Third, the study consists of a cross-sectional analysis of the relationship between conceptual understanding and implementation. A study of the process of the development of this conceptual understanding and the factors contributing to it would be an important consideration and could provide further insights.

12 Implications

Results of this study suggest that teacher's conceptual understanding of the body of knowledge underlying a complex instructional innovation is indeed an important factor for in-service teacher education, and in the research on implementation. The findings have theoretical as well as practical implications.

In the past decade, teachers' thought processes and the interaction between these processes and teachers' actions and their observable effects in the classroom have proven to be an important and fruitful topic for educational research (see Clark and Peterson, 1986). Without taking a stand in the on-going debate about the relative importance and merits of teachers' practical versus theoretical or professional knowledge (Angus, 1984), I restrict this discussion to the development of professional knowledge.

In this study, the existence of a theoretical knowledge base of the innovation made the discussion of professional knowledge, its acquisition and application, possible. The study supports the view of teachers as professionals and furthers the understanding of the cognitive dimension in the teaching process. The accepted paradigm for the study of the mental lives of teachers is generally derived from cognitive psychology and "the ultimate goal of research on teachers' thought processes is to construct a portrayal of the cognitive psychology of teaching" (Clark and Peterson, 1986). The use of an alternative theoretical framework from organizational sociology has analytical benefits: it points to new concepts and it illuminates previously obscure relationships among them, thus opening avenues for creative

research in the future and, in general, adding to the body of knowledge about the problems and the questions under study.

The findings emphasized the significance of the teacher role as the reflective practitioner and professional. The importance of thorough in-service education, formative feedback and support throughout the initial stages of implementation are self-evident. The interaction between theory and practice as exemplified in the feedback process, needs to be included in the preparation of teacher for implementation of complex innovations. The interaction between theory and practice is necessary for growth and development of understanding, as well as to provide an adequate basis for legitimate adaptations, further development of the program, and its continued implementation overtime.

Table 1

Summary of Concepts, Indicators and Sources of Data

Concept	Indicator	Source of Data
Conceptual understanding	*Index of conceptual understanding	Final Teacher Interview and Questionnaire
	in FO/D	
Non-Routine Operations	*Teacher facilitates	Teacher Observation
	*Teacher talks about cooperation and roles	Teacher Observation
	*%Students talking and working together	Whole Class Observation
	in Non-FO/D	
Transfer effects of Non-Routine Operations	*Teacher facilitates	Teacher Observation
	*Teacher talks about cooperation and roles	Teacher Observation
	*%Students talking and working together	Whole Class Observation
Classroom structural arrangements	*%Students in small groups	Whole Class Observation
Productivity	*# of curricular units covered	Final Teacher Interview

Table 2

Means and Standard Deviations for Variables

in FO/D and Non-FO/D Settings

Variable	Mean	s.d.	N
Index of conceptual understanding	21.93	8.61	15
In FO/D			
Teacher facilitates	11.06	3.84	15
Teacher talks about cooperation and roles	4.62	2.16	15
%Students talking and working together	31.43	6.80	15
In Non-FO/D			
Teacher facilitates	5.02	1.27	14
Teacher talks about cooperation and roles	0.97	1.21	14
%Students talking and working together	23.79	13.31	14
%Students in small groups	66.98	17.30	14
# of curriculum units covered	9.93	4.06	15

Table 3

Correlation Matrix of Variables in FO/D

N=15

		1	2	3	4	5
1	Index of conceptual understanding	1.0				
2	Teacher facilitates	-.62**	1.0			
3	Teacher talks about cooperation and roles	.41	-.26	1.0		
4	%students talking and working together	.31	-.43	.28	1.0	
5	# of units covered	.01	.29	-.55*	-.60**	1.0

*p<.05
**p<.01

Table 4

Correlation Matrix of Variables in Non-FO/D Settings

N=14

		1	2	3	4	5
1	Index of conceptual understanding	1.0				
2	Teacher facilitates (N-FO/D)	-.37	1.0			
3	Teacher talks about cooperation and roles (N-FO/D)	.44	.06	1.0		
4	%students talking and working together (N-FO/D)	.50*	-.35	.28	1.0	
5	%students in small groups (N-FO/D)	.09	.25	.57*	.59*	1.0

*p<.05
**p<.01

Table 5

Partial Correlations of Conceptual Understanding and Non-Routine Operations, Controlling for Organizational Arrangements

Non-FO/D settings

N=14

Independent Variable	Dependent Variable	Control Variable	Partial Correlation
Index of conceptual understanding	Teacher facilitates	%students in small groups	-.41
	Teacher talks about cooperation and roles		.47*
	%Students talking and working together		.56*

*p<.05

REFERENCES

Berman, P. and M.W.McLaughlin, Federal Programs Supporting Educational Change, Vol.VII: Factors Affecting Implementation and Continuation,Santa Monica:The Rand Corporation, April 1977.

Bruner, Jerome S.,The Process of Education, Vintage Books, New York, 1960.

Clark,C.M. and P.L.Peterson, "Teachers' Thought Processes", in M.C.Wittrock (ed.),Handbook of Research on Teaching,3rd edition, New York:Macmillan, 1986.

Cohen, E.G., Designing Groupwork: Strategies for the Heterogeneous Classroom, Teachers College, Columbia University, New York and London, 1986.

Cohen, E.G. and E.R. Bredo, "Elementary School Organization and Innovative Instructional Practices", in Baldridge,J.V. and T.E.Deal (eds.), Managing Change in Educational Organizations, Berkeley,California: McCutchan Publ. Corp, 1975.

Cohen, E.G., T.E.Deal, J.W.Meyer and W.R.Scott, Organization and Instruction in Elementary Schools, Technical Report No.50, Stanford, California: Stanford Center for Research and Development in Teaching, 1976.

Cohen, E.G. and E.A. De Avila, Learning to Think in Math and Science: Improving Local Education for Minority Children, Final Report to the Walter S. Johnson Foundation, Stanford, California: Stanford University School of Education, December, 1983.

Cohen, E.G. and J.K. Intili, Interdependence and Management in Bilingual Classrooms, Final Report to NIE, Stanford, California: Stanford University School of Education, August 1981.

Cohen, E.G. and R.A. Lotan, with C. Leechor, "Can Classrooms Learn," Sociology of Education, in press.

Cohen, E.G. with R.A. Lotan and L. Catanzarite, "Can Expectations for Competence Be Altered in the Classroom?" in M. Webster and M. Foschi, (eds.) Status Generalization: New Theory and Research, Stanford University Press, Stanford, CA 1988.

Dornbusch, S.M. and W.R.Scott, Evaluation and the Exercise of Authority, San Francisco: Jossey-Bass, 1975.

Ellis, Nancy. Collaborative Interaction and Logistical Support for Teacher Change, Unpublished doctoral dissertation, Stanford University, 1987.

Feiman-Nemser, S. and R.E. Floden, The Cultures of Teaching, in M.C.Wittrock (ed.),Handbook of Research on Teaching,3rd edition, New York:Macmillan, 1986.

Fullan, Michael. "Research on the Implementation of Educationcal Change", in Kerckhoff,A.C. and R.G. Corwin (eds.), Research in Sociology of Education and Sociolization, A Research Annual, 1981a, 2, 195-219.

----,Implementing Educational Change: Progress at Last, mimeograph,1981b.

----, The Meaning of Educational Change, Teacher College Press, Columbia University, New York and London, 1982.

Gagne, Robert M., The Conditions of Learning, Third Edition, New York: Holt, Rinehart and Winston, 1977.

Goodlad, John I., A Place Called School, New York: McGraw Hill, 1983.

Gross, N., J.Giacquinta and M. Bernstein, Implementing Organizational Innovations: A Sociological Analysis of Planned Educational Change, New York: Basic Books, 1971.

Howey, K.R. and J.C. Vaughan, "Current Patterns of Staff Development", in Griffin, G.A. (ed), Staff Development, Eighty-second Yearbook of the National Society for the Study of Education, Part II., Chicago, Illinois, NSSE, 1983, 92-117.

Intili, JoAnn K., Structural Conditions in the School that Facilitate Reflective Decision Making, Unpublished doctoral dissertation, Stanford University, 1977.

Lotan, Rachel A., Understanding the Theories: Training Teachers for Implementation of Complex Instructional Technology, Unpublished doctoral dissertation, Stanford University, 1985.

March, J.G. and Simon, H.A., Organizations, New York: John Wiley, 1958.

McLaughlin, M.W. and D. Marsh, "Staff Development and School Change", Teachers College Record, 1978, 80(1), 69-94.

McNeil, Linda M., Contradictions of Control: School Structure and School Knowledge, Routledge and Kegan Paul, New York and London, 1986.

Parchment, Charles, The Role of the Principal in the Implementation of a Complex Instructional Program, Doctoral dissertation in progress, Stanford University.

Perrow, Charles, "A Framework for the Comparative Analysis of Organizations", American Sociological Review, April 1967, 32, 194-208.

----, Organizational Analysis: A Sociological View, Belmont, Ca: Wadsworth, 1970.

Schlechty,P.C. and Whitford, B.L., "The Organizational Context of School Systems and the Functions of Staff Development", in Griffin, G.A. (ed), Staff Development, Eighty-second Yearbook of the National Society for the Study of Education, Part II., Chicago, Illinois, NSSE, 1983, 62-91.

Scott, W.Richard. Organizations: Rational, Natural and Open Systems, Prentice-Hall, Inc., Englewood Cliffs,New jersey, 1981.

Shulman, Lee. "The Psychology of School Subjects: A Premature Obituary", Journal of Research in Science Teaching, 1974, 11(4), 319-339.

Smith, L. and P. Keith, Anatomy of Educational Innovation: An Organizational Analysis of an Elementary School, New York: Wiley, 1971.

Zack, Marcia B., Managing the Classroom Using Cooperative Groupwork: An Assessment, Unpublished doctoral dissertation, Stanford University, 1988.